Original Research Article Journal of College of Medical Sciences-Nepal, Vol-15, No 2, Apr-Jun 2019

ISSN: 2091-0657 (Print); 2091-0673 (Online) **Open Access**

Comparison of Spirometric Measurements of Multi-National Undergraduate Medical Students from a Medical College of Western Nepal

Sameer Timilsina,[1] Sirisa Karki,[2] Bhuwan Baskota[3]

[1]Department of Physiology, [2]Department of Pharmacology, Chitwan Medical College, Bharatpur-5, Chitwan, Nepal.
[3]Department of Physiology, Manipal College of Medical Sciences, Pokhara-16, Kaski, Nepal.

ABSTRACT

Background: The application of pulmonary function testing is increasing in many areas of clinical medicine, including assessment of airflow limitation, diagnosis of airflow obstruction and lung restriction, evaluation of pulmonary impairment, preoperative assessment as well as public health screening. In this study, attempt has been made to evaluate Pulmonary Function Test (PFT) of healthy Nepalese young adults and compare their values with healthy Indian and Sri Lankan counterparts. Further, it tries to shed light on the correlation of these data with anthropometric parameters. **Methods:** A total of 133 pre-clinical medical students of Manipal College of Medical Sciences were included in the study. PFT was done using a computerized automatic spirometer. **Results:** All the pulmonary parameters showed significant gender differences. All mean value of PFT parameters were higher in males. The comparisons of different parameters of PFT according to gender between three countries namely Nepal, India and Sri Lanka showed that Nepalese and Indian females had a higher FEV_1 and FVC values than Sri Lankan females ($p<0.05$). Sri Lankan females had lower FEV_1 and FVC as compared to Nepalese and Indian females ($p<0.05$). However, no correlation was observed between PFTs and BMI. **Conclusions:** Although some significant differences on PFT parameters were observed in Sri Lankan data when compared with Nepalese and Indian data, no significant difference was noticed between Nepalese and Indian values of PFT. Therefore Indian prediction equation for PFT can be used for Nepal but only after further study with a larger sample size.

Keywords: India; medical students; Nepal; pulmonary function test; Sri Lanka; undergraduate.

INTRODUCTION

Spirometry is a very common yet effective diagnostic test performed routinely to evaluate lung volumes and capacities and also, lung and chest wall mechanics to determine whether or not the patient has a lung problem.[1] It measures the amount of air that moves in and out of the lungs during various respiratory maneuvers. Not only is it used to diagnose various respiratory conditions, but also, it is useful in assessing the physiological lung function.[1] It has paved a pathway for diagnosing and monitoring of patients with several respiratory diseases and is the gold standard for diagnosing and assessing treatment response for obstructive lung diseases.[2,3] From physiological perspective, spirometric measurements are either static or dynamic. Dynamic lung volumes typically depend on air flow rate and are mostly derived from vital capacity. Both dynamic and static lung volumes are essential for evaluation of obstructive as well as restrictive pulmonary diseases.[4] The lung volumes include the tidal volume (TV), inspiratory reserve volume (IRV), expiratory reserve volume (ERV) and residual volume (RV). Likewise, the lung capacities include Vital Capacity (VC), Inspiratory capacity (IC), Functional Residual Capacity (FRC) and Total Lung Capacity (TLC). With standard spirometer, RV, FRC and TLC cannot be measured, moreover requiring special techniques.[5] Some of the relatively important parameters like Forced Expiratory Volume in first second (FEV_1), Forced Vital Capacity (FVC), FEV_1/FVC, Peak Expiratory Flow Rate (PEFR), Maximum Voluntary Ventilation (MVV) are the key in assessment and evaluation of respiratory disease.[6] Spirometry is relatively easier procedure and its interpretation depends on comparison with reference values established according to age, sex, Body Mass Index (BMI) and ethnicity.[7] Besides race, age, sex, height, weight physical activity patterns, pulmonary function test (PFT) values are

Correspondence: Dr. Sameer Timilsina, Department of Physiology, Chitwan Medical College, Bharatpur-5, Chitwan, Nepal. **Email:** timilsina.sameer@cmc.edu.np. **Phone:** +9779803789390. **DOI:** 10.3126/jcmsn.v15i2.21314. **Article received:** 2018-10-09 . **Article accepted:** 2019-05-06.

influenced by environmental, genetic, socio-economic, nutritional status, geographic condition, ethnic and racial origin and technical parameters.[8] However, interpretation of pulmonary function measurements is complicated by the fact that the predicted values from different published studies vary in different individuals.[9] The clinical practice in respiratory medicine in Nepal relies entirely on unusual normal reference values and we cannot speculate whether it reflects the lung capacity of Nepalese population.[10-13] The neighboring countries India and Sri Lanka share same fate as Nepal in terms of socio-economic, geographic, environmental and nutritional conditions. In this study we aim to measure the normative data of lung function indices (FEV_1, FVC, FEV_1/FVC, PEFR and MVV) of Nepalese, Sri Lankan and Indian pre-clinical medical students of Manipal college of Medical Sciences and compare their values. Further, we aim to investigate the correlation of lung function indices with anthropometric parameters.

METHODS

This was a cross-sectional study conducted at Manipal College of Medical Sciences, Pokhara (827m above sea level) from September 2016 to February 2017. Ethical clearance for the study was obtained from Ethical and Review Committee of Manipal College of Medical Sciences. A total of 133 medical students (51 Nepalese, 41 Indian and 41 Sri Lankan) aged 17-24 years were included in the study. A written informed consent was obtained from all the students for participation in the study. The participants were screened to exclude cardiopulmonary or other diseases that could affect pulmonary function. Students with history of asthma, chronic bronchitis, respiratory infection at the time of participation and surgery involving the chest wall were excluded from the study. The height (cm), weight (kg), sex was documented using a working porforma. Pulmonary Function Test was performed using a *Schiller SP-250* computerized spirometer. The device was calibrated every day and was used regularly as a part of undergraduate practical tool. Participants were briefed about the procedure beforehand and the procedure was carried out according to the ATS/ERS 2005 guideline.[14] All the procedures were carried out by the same investigator. A nasal clip was applied ensuring mouth breathing only. They were instructed to take a deep breath and blow into the mouth piece as quickly and as forcefully as possible. The participants were advised to sit comfortably on the chair and three readings for Forced Vital capacity (FVC), Forced Expiratory Volume in 1st second (FEV_1), and Peak Expiratory Flow Rate (PEFR) were taken with the highest value recorded for the study. MVV was recorded for 10 seconds by fast and deep breathing and was expressed as L/min.

Vital capacity: It is the maximum amount of air a person can expel form the lungs after a maximum inhalation. (3-5L)

FVC: It is the volume of air that can forcibly be blown out of the lungs after full inspiration.

FEV_1: It is the volume of air that can be forcibly blown out of the lungs during the first second of expiration, after full inspiration.

PEFR: It is the maximal flow of air achieved during the maximally forced expiration initiated at full inspiration.

MVV: The maximum amount of air that can be exhaled or inhaled within one minute by voluntary fast and deep breathing.

The obtained data was recorded and analyzed using Statistical Package for Social Sciences (SPSS ver. 20). The numerical values were expressed as mean±SD. Shapiro Wilk test was done to check the normality of distribution of different variables. Student *"t"* test and Pearson's correlation coefficient (R) was used to obtain correlation between all obtained spirometric measurements and physical parameters (height, weight). One way ANOVAs was done to compare the pulmonary parameters (FVC, FEV1, FEV1/FVC, PEFR, and MVV) for different nationalities. Statistical significance was considered at $p<0.05$.

RESULTS

Among 133 participants in the study (Male (M) =68 Female (F) =65), the mean age of the participants was 19.76±1.26 years (M=20.04±1.36 years F=19.47±1.07years), height was 1.63±0.07 meters (m) (M= 1.69±0.06m F=1.57±0.04m), weight was 61.73±12.03 kg (kilogram) (M=67.13±12.37kg F=56.09±8.66kg) and BMI was 22.98±3.56 kg/m^2 (M= 23.44±3.73 kg/m^2 F=22.49±3.33 kg/m^2). The physical characteristics of males and females with of different nationalities is presented in Table 1.

All the values of PFT were normally distributed across all nationalities. The mean FVC was 4.18±0.81 Liters (L) (M=4.75±0.69 L F=3.58±0.47 L), FEV1 was 3.66±0.66 L (M=4.53±0.13L F=3.17±0.36 L), FEV1/FVC was 0.87±0.05 (M=0.87±0.05 F=0.88±0.05), PEFR was 9.15±1.93 L/min (M=10.51±1.55 L/min F=7.72±1.08 L/min) and MVV was 151.79±35.49 L (M=179.59±26.36 L F=122.71±13.80 L). Table 2 presents the inter-country mean pulmonary parameters among males

Table 1. Physical characteristic of students of 3 different countries.

Parameter	Nepal		India		Sri Lanka	
	Male (n=28)	Female (n=23)	Male (n=20)	Female (n=21)	Male (n=20)	Female(n=21)
Age (years)	20.00±1.3	19.21±0.95	19.45±1.43	19.38±0.80	20.70±1.12	19.85±1.35
Height (cm)	1.67±0.06	1.56±0.02	1.70±0.06	1.58±0.05	1.69±0.03	1.58±0.04
Weight (kg)	63.92±8.89	56.00±8.54	70.2514.13	56.28±9.46	68.50±14.16	56.00±8.40
BMI(kg/m^2)	22.73±2.6	22.77±3.29	24.07±4.15	22.36±3.54	23.81±4.54	22.33±3.29

BMI: Body Mass Index

Table 2. Gender-wise Inter-Country Pulmonary Function Parameter.

Parameter	Nepal		India		Sri Lanka	
	Male (n=28)	Female (n=23)	Male (n=20)	Female (n=21)	Male (n=20)	Female (n=21)
FVC (L)	4.73±0.63	3.64±0.41	4.94±0.78	3.79±0.49	4.60±0.47	3.32±0.39
FEV_1 (L)	4.02±0.47	3.24±0.36	4.30±0.69	3.31±0.36	4.10±0.37	2.96±0.27
FEV_1/FVC	0.85±0.06	0.89±0.04	0.87±0.05	0.87±0.06	0.89±0.04	0.89±0.04
PEFR (L/min)	10.27±1.44	7.92±1.21	10.33±1.83	7.71±1.15	11.04±1.33	7.52±0.85
MVV (L/min)	178.14± 26.10	127.38± 16.16	179.97± 29.90	121.42± 13.14	181.23± 24.15	118.89± 10.36

FVC: Forced Vital capacity, FEV_1: Forced Expiratory Volume in 1st second, PEFR: Peak Expiratory Flow Rate, MVV: Maximum Voluntary Ventilation

and females. On gender wise comparison of pulmonary parameters, it was found that Nepalese and Indian females had higher pulmonary parameter values compared to Sri Lankan females ($p<0.05$). In spite of the higher values, no significant inter country differences was observed with FEV1/FVC, PEFR and MVV. There were no significant differences in FVC, FEV1, PEFR, and MVV among males of different countries. Table 3 presents the inter country correlation of pulmonary parameters among female students. Overall, pulmonary parameters, FEV1 (p=0.014 R=0.298), FVC (p=0.000 R=0.428) and PEFR (p=0.025 R=0.271) showed a weak positive correlation with weight among males but no such relationship was observed among females. Likewise, FEV1/FVC (p=0.023 R=-0.275) showed a weak negative correlation with weight among males. Similarly, strong positive correlation was observed with FVC (R=0.641, $p<0.001$) and FEV1 (R=0.669, $p<0.001$), and, weak positive correlation was seen with PEFR (R=0.439, $p<0.001$) with height among males. Table 4 shows the paired sample correlation of weight with various pulmonary parameters among males. No such relationships was observed among females. Pulmonary Function test values correlated with longitudinal dimensions especially with height, while the correlation with weight was considerably lower. Height was the only physical parameter among females showing weak positive correlation with FEV1 (R=0.287 p=0.020) and FEV1/FVC (R=0.253 p=0.042).

Table 3. Correlation of inter country pulmonary parameter among females.

Parameter	Nationality		p-value
FVC	Nepal	India	p>0.05
		Sri Lanka	p<0.05
FEV_1	Nepal	India	p>0.05
		Sri Lanka	p<0.05
FEV_1/FVC	Nepal	India	p>0.05
		Sri Lanka	p>0.05
PEFR	Nepal	India	p>0.05
		Sri Lanka	p>0.05
MVV	Nepal	India	p>0.05
		Sri Lanka	p>0.05

FVC: Forced Vital capacity, FEV_1: Forced Expiratory Volume in 1st second, PEFR: Peak Expiratory Flow Rate, MVV: Maximum Voluntary Ventilation

Table 4. Relationship of height and weight with pulmonary parameters among males. (n=68)

Physical Parameter	Pulmonary parameter	Pearson's R	"p" value
Height	FEV_1	0.669	0
	FVC	0.641	0
	FEV_1/FVC	0.028	0.821
	PEFR	0.439	0
	MVV	0.22	0.071
Weight	FEV_1	0.298	0.014
	FVC	0.428	0
	FEV_1/FVC	-0.275	0.023
	PEFR	0.271	0.025
	MVV	0.033	0.787
BMI	FEV_1/FVC	-0.315	0.009

Abbreviations: *PFT, pulmonary function tests; FEV_1, forced expiratory volume in 1st second; FVC, forced vital capacity; PEFR, peak expiratory flow rate; MVV, maximum voluntary ventilation.*

DISCUSSION

Spirometry is the widely used screening tool for pulmonary function studies. Owing to its simple features, portability and accessibility, it can be used in ambulatory patients, outpatient, inpatient and emergency departments. It is generally expected that increased physical activity improves physical fitness. BMI (Body Mass Index) has been used as a measure of physical and cardio-pulmonary fitness. BMI as recommended by the Asian Indian population cutoff point of 23 kg/m^2 showed Indian (65%) and Sri Lankan (55%) males had higher values while Nepalese males BMI values were within normal limits.[15] The increasing global prevalence and trends of being overweight and obese owing to rapid urbanization in India and Sri Lanka could be the reason for such a finding.[16] However, these data cannot be generalized among the general population as the sample size is very small and the existing rich-poor gap in both these countries.[17] Also, the participants in the study were first year medical students who are yet to face the academic rigor and stress. These factors could increase metabolism and actually help reduce the BMI. However, according to the WHO guideline, the calculated BMI in the present study was within normal limits. We failed to find a correlation between pulmonary parameters and BMI in overall cases but found BMI correlating negatively with FEV_1/FVC in males.[18] Considering the pulmonary parameters, the higher values were obtained for males than females (except FEV_1/FVC) were supported by several studies.[19-21] Females tend to have lower values due to small lung size, reduced airway diameter, decreased maximal expiratory flow and less diffusion area. Also, progesterone and estrogen are said to modify pulmonary functions.[22, 23] PFT correlated best with height. The significant positive correlation observed with FEV_1, FVC and PEFR with height was in line with the several other studies.[16, 24-26] Similar findings could have been the result of the study group as all these studies were done in university students. In our present study, we fail addressing the association of pulmonary function tests with race and ethnicity which could as well influence the results. In spite of the fact that PFT values obtained were similar to the present study, there was some racial and ethnic variance in the studies.[24, 25] The genetic and environmental factors have been said to affect the pulmonary function, thus varying values for different race and ethnicity.[27]The significant positive correlation of FEV_1 and FVC with weight in the present study has been corroborated with several literatures[12, 26, 28] but some studies have shown a negative correlation.[16] The reason behind this discrepancy is not known. In the present study, Sri Lankan females were found to have lower values for pulmonary parameters as compared to their Nepali and Indian counterparts. It could be the effect of altitude on lung function. People living in highlands have higher values of pulmonary parameters to those living in low altitude.[29] As the average altitude in Sri Lanka is less than that in Nepal and India, there could have been some difference. However, the present study is in no condition to speculate as to why the same results were not obtained among Sri Lankan males. The study participants were pre-instructed regarding the pre-procedural do's and don'ts according to the guideline provided by the American Thoracic Society but it cannot be guaranteed if they were followed which could be a limitation of the study. Also, the reluctance of the medical students giving smoking history in spite of assured anonymity could as well be the other limitation of the study. Even though it is difficult to establish proper, reliable values for pulmonary function tests owing to complexity of different factors influencing lung function, Indian prediction equation can be utilized for Nepal, more so over larger studies should be conducted before reaching to any conclusion.

CONCLUSIONS

From the present study, it can be concluded that pulmonary function tests values are within normal limits among the undergraduate medical students studying at Manipal College of Medical

Sciences. All pulmonary function parameters are higher in males than in females among Nepalese, Indian and Sri Lankan adolescents and young adults. Pulmonary Function Test best correlates with height, ie a tall individual might have higher pulmonary values. As no significant difference was seen between Nepalese and Indian values of PFT, Indian prediction equation for PFT can be used for Nepal. However, further studies with large sample size is advised.

ACKNOWLEDGEMENTS

We would like to thank the ethical committee of Manipal College of Medical Sciences for providing us the consent to conduct this study at this esteemed institute. We would also like to whole heartedly thank the participants of the study without whom the study would not have been possible. We are highly indebted to Prof Dr. D Sarkar, HOD and all faculties of Department of Physiology, Manipal College of Medical Sciences for their continuous encouragement and support in the field of research. We would also like to thank Dr. Indu Tiwari, Dr. Pragati Koirala, Dr. Punya Laxmi Manandhar, and Mr. Madhav Poudel for their help and support.

Disclosure

The author reports no conflicts of interest in this work. Ethical approval was obtained from the Ethics and Research Committee, Manipal College of Medical Sciences, Pokhara, Nepal. All procedures were in accordance with the Helsinki declaration and its later amendments. There was no funding available for the study and it was conducted solely for research purpose on researchers' interest.

REFERENCES

1. Sewa DW and Ong TH. Pulmonary Function Test: Spirometry. *Proceedings of Singapore Healthcare.* 2014;23(1):57-64.
2. Moore VC. Spirometry: step by step. *Breathe.* 2012;8(3):232-240.
3. Johns DP, Walters JAE and Walters EH. Diagnosis and early detection of COPD using spirometry. *Journal of Thoracic Disease.* 2014;6(11):1557-1569.
4. Lutfi MF. The physiological basis and clinical significance of lung volume measurements. *Multidisciplinary Respiratory Medicine.* 2017;12:3.
5. Flesch JD and Dine CJ. Lung volumes: measurement, clinical use, and coding. *Chest.* 2012;142(2):506-510.
6. Stanojevic S, Wade A, Stocks J, et al. Reference Ranges for Spirometry Across All Ages: A New Approach. *American Journal of Respiratory and Critical Care Medicine.* 2008;177(3):253-260.
7. Mc Neill M and Nolan G. Spirometry Performance and Interpretation for Healthcare Professionals Ireland 2015:19.
8. Vaz Fragoso CA, McAvay G, Gill TM, Concato J, Quanjer PH and Van Ness PH. ETHNIC DIFFERENCES IN RESPIRATORY IMPAIRMENT. *Thorax.* 2014;69(1):55-62.
9. Braun L. Race, ethnicity and lung function: A brief history. *Canadian Journal of Respiratory Therapy: CJRT = Revue Canadienne de la Thérapie Respiratoire : RCTR.* 2015;51(4):99-101.
10. Nepal GB, Das PKL and Bhaila A. Spirometric evaluation of pulmonary functions of medical students in Nepal. *Asian Journal of Medical Sciences.* 2014;5(3):82-86.
11. Prajapati R, Upadhyay Dhungel K, Pramanik T, Ghosh A and Roychowdhury P. Assessment of some pulmonary parameters and cardiorespiratory fitness status in Nepalese medical students. *Nepal Med Coll J* 2008;10 (1):28-29.
12. Deo SK and Dev S. Pulmonary Function Parameters in Healthy Nepalese Population. *Int J Curr ResMed Sci.* 2016;2(8):40-45.
13. Chatterjee P, Das P, Debnath P and Banerjee AK. A comparative study of vital capacity of Indian and Nepalese young female. *Journal of Physical Education and Sports Management.* 2010;1(2):25-27.
14. Miller MR, Hankinson J, Brusasco V, et al. Standardisation of spirometry. *Eur Respir J.* 2005;26(2):319-338.
15. Amatya M. *Body mass index of Nepalese medical students: a cross-sectional study.* Vol 42014.
16. Bandyopadhyay A, Bhattacharjee I, Dalui R and Pal S. Pulmonary Function Studies of Healthy Non-smoking Male University Students of Kolkata, India — Revisited. *The Malaysian Journal of Medical Sciences : MJMS.* 2013;20(2):17-24.
17. Ranjani H, Mehreen TS, Pradeepa R, et al. Epidemiology of childhood overweight & obesity in India: A systematic review. *The Indian Journal of Medical Research.* 2016;143 (2):160-174
18. R Joshi A and Singh R. *Correlation of pulmonary function tests with body fat percentage in young individuals.* Vol 522008.

19. Berens A, Doro K, Heiman M, Bredle D and Ishikawa S. Association between posture and pulmonary function in middle age and older people. *Journal of Undergraduate Kinesiology Research* 2014;9(2):11-19.
20. Abbas AH. Spirometric Assessment In Undergraduate Medical Students. *Journal of Babylon University/Pure and Applied Sciences*. 2018;26(1):283-288.
21. Vilke GM, Chan TC, Neuman T and Clausen JL. Spirometry in normal subjects in sitting, prone, and supine positions. *Respir Care*. 2000;45(4):407-410.
22. Card JW and Zeldin DC. Hormonal Influences on Lung Function and Response to Environmental Agents: Lessons from Animal Models of Respiratory Disease. *Proceedings of the American Thoracic Society*. 2009;6(7):588-595.
23. Alghadir A, Aly F and Zafar H. Sex-Based Differences in Lung Functions of Saudi Adults. *JPhys Ther Sci*. 2012;24(1):5-9.
24. Manuel BJ and Arnaldo M. Relationship between the lung function and anthropometric measures and indexes in adolescents from Córdoba, Argentina. *American Journal of Human Biology*. 2010;22(6):823-829.
25. Bhatti U, Rani K and Memon MQ. Variation in lung volumes and capacities among young males in relation to height. *J Ayub Med Coll Abbottabad*. 2014;26(2):200-202
26. Udupihille M. Spirometric and flow standards for healthy adult non-smoking Sri Lankans belonging to the Sinhalese ethnic group. *Annals of Human Biology*. 1995;22(4):321-336.
27. Tarnoki DL, Tarnoki AD, Lazar Z, et al. Genetic and environmental factors on the relation of lung function and arterial stiffness. *Respiratory Medicine*. 2013;107(6):927-935
28. Diogenis S, Emmanouil P, Grigorios T, et al. The effect of obesity on pulmonary lung function of school aged children in Greece. *Pediatric Pulmonology*. 2009;44(3):273-280.
29. Greksa LP, Spielvogel H, Paz-Zamora M, Caceres E and Paredes-Fernandez L. Effect of altitude on the lung function of high altitude residents of European ancestry. *Am J Phys Anthropol*. 1988;75(1):77-85.

Citation: Timilsina S, Karki S, Baskota B. Comparision of the Spirometric Measurements of Multi-National Undergraduate Medical Students from a Medical College of Central Nepal. JCMS Nepal. 2019; 15(2):144-9.